REMARKS

Favorable reconsideration is respectfully requested.

Upon entry of the above amendment, the claims will be 1 and 3 to 5.

The above amendment is responsive to points set forth in the Official Action.

Support for the above amendment is evident from page 15, line 5 of the present specification.

The significance of this amendment will become further apparent from the remarks below.

Claims 1 to 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ishii et al. (U.S. 5,368,921) in view of Sakaguchi et al. (EP 768,814), Touzaki (JP 11-77892), and Kawakita et al. (U.S. 5,817,404).

This rejection is respectfully traversed.

According to the present invention, there is provided a copper-clad laminate of a glass fabric/thermosetting resin base material, the laminate having a small diameter hole with a diameter of 0.15 mm or less formed by irradiation with a carbon dioxide gas laser. The base material is formed of prepreg obtained by impregnating a glass fabric base material made of a glass woven fabric having a thickness of 25 to 40 μm, a weight of 15 to 27 g/m^2 and a gas permeability of 1 to 20 $cm^3/cm^2/sec.$ with a thermosetting resin composition which is dissolved in a solvent. The thermosetting resin composition in the copper-clad laminate contains an insulating inorganic filler in an amount of 10 to 80% by weight based on the above resin composition. The thus impregnated base material is then dried.

According to the present invention, there is provided a glass fabric base material/thermosetting resin copper-clad laminate in which a small-diameter hole, of which the wall is highly reliable, can be formed with a high-output carbon dioxide gas laser at a high speed.

The cited references and differences from the present invention will now be discussed.

Ishii et al. (U.S. 5,368,921) relates to a metal foil-clad laminate obtained by laminate molding a resin-impregnated substrate containing from 5 to 30% by weight of an inorganic filler having a specific particle diameter such as an average particle diameter of 0.1 to 5 μm and a metal. Ishii et al. discloses that owing to the above structure there is provided a surface smooth metal foil-clad laminate having a diminished surface undulation attributable to the resin

impregnated substrate (see claim 1). Ishii et al. discloses that the preferred thickness of the substrate to be used (a nonwoven glass fabric) is from 0.05 to 0.2 mm (see col, 2, line 66).

Ishii et al. do not at all disclose or suggest the thickness, weight and gas permeability requirements of the glass woven fabric of the present invention. Further, Ishii et al. do not at all teach that small-diameter holes having a diameter of 0.15 mm or less and excellent in the reliability of hole walls can be made by irradiation with a carbon dioxide gas laser at a high speed, as a result of satisfying the requirements of the present invention.

Sakaguchi et al. (EP 768814) disclose a woven glass cloth having a mass of 15 to 30g/m^2 and a prepreg having a thickness of 0.040 to 0.080 mm, suitable for use as a base material to be resin-impregnated for printed wiring board material. (See claims 1 and 9).

Sakaguchi et al. further disclose a woven glass cloth having a weight and a thickness, each of which is common to those of the present invention. However, Sakaguchi et al. do not disclose or suggest that the gas permeability must have a specific value which is required in order to incorporate a specific amount of an insulating inorganic filler and that holes having a small diameter are made by irradiation with a carbon dioxide gas laser. Furthermore, Sakaguchi et al. do not at all disclose or suggest that small-diameter holes having a diameter of 0.15 mm or less excellent in the reliability of hole walls can be made at a high speed owing to the satisfaction of the above requirements.

Thus, both Ishii et al. and Sakaguchi et al. do not at all teach a copper-clad laminate of a glass/thermosetting resin base material which satisfies the requirements of the present invention, and is particularly suited for the formation of holes by irradiation with a carbon dioxide gas laser.

Touzaki (JP 11-77892) discloses a process for the production of copper-clad laminate which process comprises fluidizing a resin composition which is solid or semisolid at normal temperature through heating, applying the fluidized resin composition to a copper foil, then, loading a fiber base material thereon, laminating another copper foil and then heating the resultant set to integrate and cure it.

Touzaki's object is to provide a process for the production of copper-clad laminate wherein the resin composition to be used is substantially a non-solvent resin composition and the resin composition can be impregnated into the fiber base material without leaving air bubbles in the base material ([0003], [0005]).

Touzaki discloses a glass fiber woven fabric as the fiber base material. Further, Touzaki

discloses that a glass fiber woven fabric having a gas permeability of 1-15 cc/cm^2/sec formed by opening is preferred and that when the gas permeability is larger than 15 cc/cm^2/sec, undesirably, air bubbles are left in the base material in some cases [(0010)].

In Touzaki, the resin composition is fluidized through heating and applied to the copper foil and then the fiber base material is loaded thereon, thereby impregnating the resin composition into the fiber base material. Glass cloth having a thickness of 50 μm was used as the fiber base material in the respective Examples.

In contrast, in the present invention, holes having a diameter of 0.15 mm or less are made by irradiation with a carbon dioxide gas laser in a copper-clad laminate using prepreg obtained by impregnating a thermosetting resin composition dissolved in a solvent into a glass fiber having a specific thickness, a specific weight and a specific gas permeability.

Thus, due to the satisfaction of the above limitations, the present invention provides a copper-clad laminate having a small-diameter hole having a highly reliable hole wall.

Touzaki merely discloses that the fiber base material having a specific gas permeability is preferable for the purpose of impregnating the resin fluidized through heating into the fiber base material without leaving air bubbles.

In other words, Touzaki does not at all teach or suggest that a small-diameter hole is made in a copper-clad laminate comprising prepreg using a solvent-soluble resin with a carbon dioxide gas laser, that the specific gas permeability, thickness and weight are required therefor, and that a small-diameter hole having a hole wall with high reliability can be obtained by satisfying the above requirements.

Kawakita et al. (U.S. 5,817,404) discloses a printed circuit board, comprising a resin impregnated fabric sheet, an electrically conductive portion, and a thermally conductive portion wherein at least a surface layer portion of the thermally conductive portion has electrical insulating properties (col. 1, line 61 to col. 2, line 7) and also discloses that the electrically conductive portion has a through hole filled with electrically conductive particles, and the thermally conductive potion has a through hole filled with thermally conductive particles.

Kawakita et al. describes in column 10, lines 45 to 51 that "an aramid-epoxy sheet having a thickness of 200 μm is used as a prepreg. A polyethylene terephthalate film having a thickness of 20 μm is laminated as a cover film onto one of the sides of the prepreg with an adhesive. A through hole having a diameter of 0.15 mm is formed at regular intervals of 0.2 to 2 mm by

means of carbon dioxide laser beams."

The rejection states it would have been obvious to a person having ordinary skill in the art at the time of the invention to make small diameter holes in the composite of Ishii et al. in order to improve performance of the circuit board, as taught by Kawakita et al. (page 3, lines 4-1 from the bottom).

In reply, material in which holes are formed by carbon dioxide gas laser irradiation in Kawakita et al. is a prepreg having no copper foil, specifically an aramid-epoxy sheet.

The rejection states that Kawakita et al. disclose that in fact, through holes can be formed in glass epoxy laminates (column 11, lines 24 and 25), (page 6, lines 4 and 5).

However, the above portion of Kawakita only discloses that the coefficient of thermal expansion of the semi-conductor is different from that of a conventional glass epoxy board on which through holes are formed. However, the above portion does not disclose or suggest that through holes are formed in the glass epoxy board with a carbon dioxide gas laser.

In contrast, the present invention relates to a copper-clad laminate obtained by forming a hole in a copper foil surface of a glass fabric base copper-clad laminate by irradiation with a carbon dioxide gas laser. The material to be processed in the present invention is completely different from that of Kawakita et al.

The laser energies required for forming holes in a resin composition, a glass woven fabric and a copper layer respectively become larger in the order of resin composition < glass woven fabric < copper foil. When the material to be processed has no copper layer, a through hole can be formed in the material with a relatively small energy. However, when a copper layer is present, such small energy is interrupted by the copper layer and therefore a through hole cannot be formed.

When an energy sufficient to form a hole in the copper layer is used, the resin composition is irradiated with the excess energy, so that the circular form of hole cannot be retained, the wall of hole has large roughness and reliability is decreased.

Kawakita et al. do not disclose or suggest laser processing conditions for resin composition at all. Thus, it is impossible to provide a thermosetting resin composition of a glass fabric base material which has practicality and a highly reliable hole form and hole wall by merely forming a hole in the resin composition disclosed by Kawakita et al. by carbon dioxide gas laser irradiation.

The present invention provides a novel copper-clad laminate obtained by forming holes in a copper-clad laminate by irradiation with a carbon dioxide gas laser, for overcoming the difficulty of formation of holes with a carbon dioxide gas laser.

None of the cited references disclose or suggest the present invention which is provided for overcoming the above difficulty. It is completely unobvious to arrive at the present invention from such cited references, alone or combined.

No further issues remaining, allowance of this application is respectfully requested.

If the Examiner has any comments or proposals for expediting prosecution, please contact undersigned at the telephone number below.

Respectfully submitted,

Morio GAKU et al.

THE COMMISSIONER IS AUTHORIZED TO CHARGE ANY DEFICIENCY IN THE FEES FOR THIS PAPER TO DEPOSIT ACCOUNT NO. 23-0975

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